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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubricating the Modern Machine Tool

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

INCREASED LIFE AND ACCURACY

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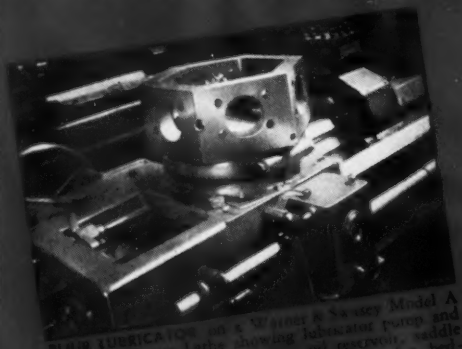
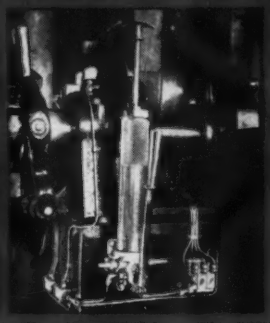
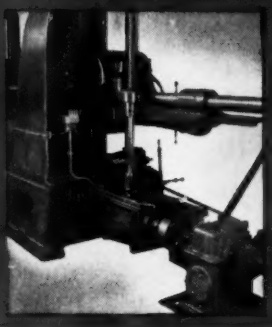


BIJUR LUBRICATION on a Warner & Swasey Model A Turret Lathe showing lubricator pump and oil reservoir, saddle mounting for bedway lubrication.

BOWEN Centralized Lubrication System, standard equipment on Norton Grinding Machine, 6 x 18 type C hydraulic traverse.



TRABON Lubrication System in application to the high-speed end of a Screw Machine with greatly improved lubricating results.



FARVAL DX Multiple Measuring Valve Lubrication System on Lucas Horizontal Boring Mill at Cleveland Worm and Gear Company's plant.

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Lubricating the Modern Machine Tool

METAL working has been an art since the days of Tubal Cain. Progressively it has dealt with harder and harder materials from relatively pure gold and silver to copper, iron, and alloy steels. As the machine age was developed, the metallurgist became more and more of a factor. He was called upon to study the perfection of harder steels which would be more resistant to wear, with adequate tensile strength to withstand shock loads of great severity. For such steels must be machined to extreme accuracy, and capable of grinding and polishing to a mirror finish.

The machinery for working these materials required equal consideration for, as precision in production was perfected, precision in machine assembly and the working of the component parts also became necessary. All this, the machine tool designer has accomplished with the aid of the steel chemist and metallurgist who have given him the raw materials to work with.

The modern machine tool, however, required another industry to insure that in service its maintenance would not be too costly. Petroleum had to furnish the basic lubricants. Furthermore, methods of lubrication had to be devised which would assure of positive delivery of grease or circulation of oil, according to the function and requirements of the parts involved.

Such machinery includes a variety of ball and roller bearings, trains of carefully cut gears which are housed and flood lubricated, and sliding surfaces such as V's which must be continuously in perfect alignment. So lubrication becomes a most important adjunct to machine tool operation and maintenance.

The machine tool industry has turned extensively to automatic lubrication as an adjunct to precision cutting and finishing of metals. This has required perfection of fully-enclosed mechanisms in oil-tight housings. It followed naturally that the industry should also adopt the ball and roller bearing. All these refinements led to the use of quality lubricants, for waste became virtually negligible; also the precise nature of the mechanisms required more positive protection. This could only be assured by highly refined lubricating oils and greases. These are most resistant to breakdown and oxidation under the catalysing conditions which so often prevail, viz., heat and agitation in the presence of copper or copper alloys.

In other respects, the selection of machine tool lubricants depends upon the method of application and the duty involved. In general, there are certain definite requirements which oil must possess, i.e.:

1. Sufficient body or viscosity to prevent metal-to-metal contact of the surfaces to which it is applied, but not so heavy as to produce high internal friction.
2. An ability to flow readily when low service temperatures are involved.
3. Ability to stand up under continued ser-

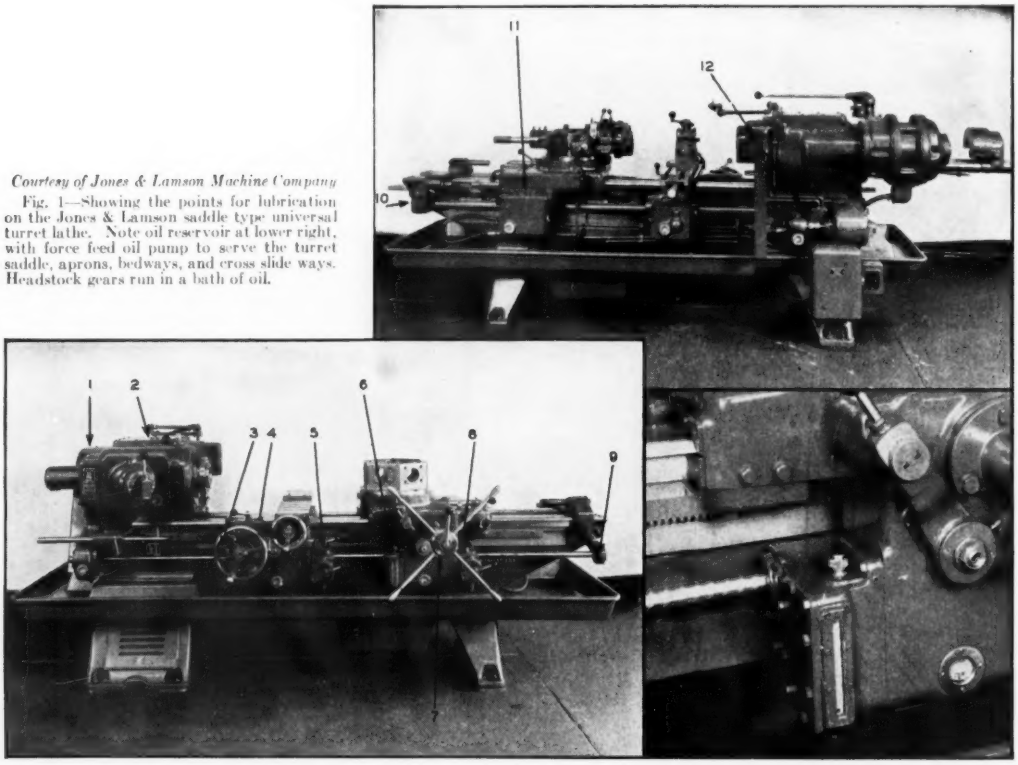
vice without any excessive tendency toward decomposition or gumming.

4. Ability to meet special service requirements, such as quick water separation, a low degree of vaporization, and the least tendency toward emulsification.
5. Freedom from impurities which might prove injurious to the system.

LATHES

Gearing is an important part of a lathe assembly, for the speed of a lathe is usually considerably lower than the speed of the driving motor. Such gearing is enclosed in the head. Quick change gear feeds operate the power feeds; back gears are installed on certain types of engine lathes; and bevel pinions and gears are found in some lathe aprons to reverse the direction of feed.

Bath or splash feed lubrication predominate in modern lathe gear sets. They insure against the possibility of abnormal wear; they also render operation relatively noiseless and preclude the occurrence of back-lash. Furthermore, the one lubricant can be made to serve all gears and bearings in the assembly.



Courtesy of Jones & Lamson Machine Company

Fig. 1—Showing the points for lubrication on the Jones & Lamson saddle type universal turret lathe. Note oil reservoir at lower right, with force feed oil pump to serve the turret saddle, aprons, bedways, and cross slide ways. Headstock gears run in a bath of oil.

Types of Lubricants

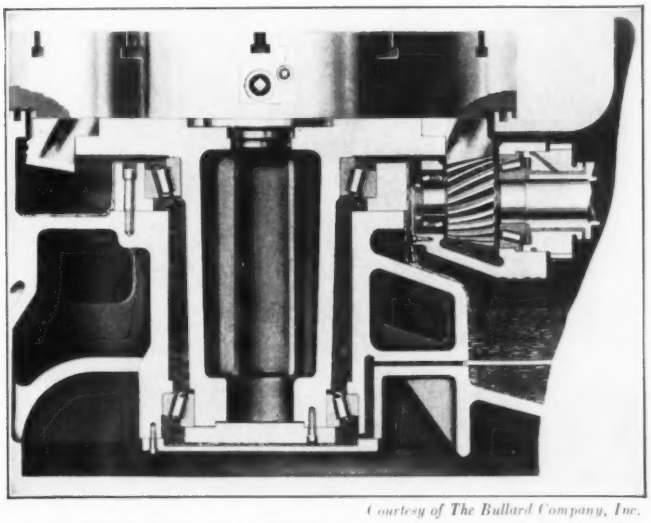
In most machines these gears are comparatively small and so carefully designed, cut, and aligned that unless excessive bearing wear takes place, lubrication can be effected by means of a relatively fluid lubricant. An oil of from 300 to 500 seconds viscosity will have sufficient body to prevent metallic contact between the gear teeth and still be light enough to penetrate effectively to all bearing clearances.

In the case of vertical or larger types of horizontal turret lathes, however, a heavier bodied oil may be advisable for certain of the larger gears. This will be especially true where the gears are enclosed, but have their bearings so located without the gear case as to permit of independent lubrication. In such installations, a lubricant within the S.A.E. 90 or 140 range may be advisable, depending on the closeness of mesh and whether back-lash is prone to occur.

Yet, while a heavier lubricant will eliminate a certain amount of the noise of operation and the pounding and hammering due to back-lash, especially when speeds are changed, the use of too viscous a product might readily involve serious power losses on account of the added friction developed by the gears moving through the more or less inert bath of lubricant.

All machine gears, however, are not so enclosed as to permit of bath lubrication, viz., the back gears of certain types of engine lathes. Such gears must be lubricated by direct application of the lubricant to the teeth.

In service of this nature, the lubricant must not only be sufficiently viscous to preclude the occurrence of metallic contact between the teeth, but also it must be so adhesive as to stick tenaciously to these latter and resist the action of centrifugal force. Straight mineral gear lubricants, ranging in viscosity from 1000 to 2000 seconds Saybolt at 210 degrees Fahr., overcome this difficulty and meet both requirements.



Courtesy of The Bullard Company, Inc.

Fig. 2—A Bullard table drive and headstock mechanism on a vertical turret lathe. Lubrication is provided by pump circulation of oil from the reservoir in the base of the bed. Note application of roller bearings, and the spiral bevel drive pinion running in a bath of oil delivered under pressure.

Bearings, Guides and Slides

Lathe bearings may involve a number of types. There are the thrust bearings which take up the end thrust exerted by the spindle; they may be of the plain sleeve type, or they may involve ball bearings. Other rotating members may be carried in plain babbitt or phosphor-bronze bearings, or in ball or roller bearings. Spindle sleeve bearings should be adjustable to compensate for wear.

The higher the speeds, the more attention must be given to the bearings, also to their lubrication. This is why phosphor-bronze is so extensively used as a bearing metal for the high speed journals in lathe heads.

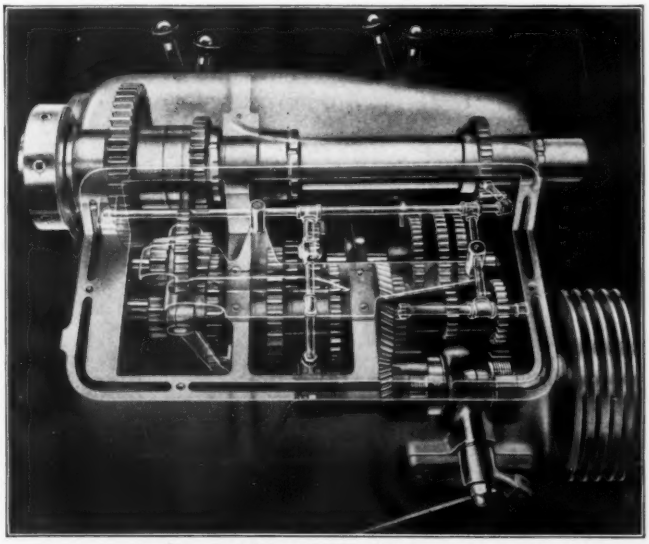
Slides or guides include the lathe bed on which the carriage moves, and the guides on which the turret saddle and cross-slide carriage travels. Motion over a lathe sliding surface is relatively slow, but the pressures involved are high. Therefore, wear may easily become excessive, with the probability of increased power consumption, if such surfaces are not properly constructed and lubricated.

Wherever abnormal friction occurs, the tendency will be for the lathe bed to wear hollow. For this reason, on most machines it is built of a high grade alloy casting and stiffened with box girders. Some are also flame-hardened to develop added resistance to wear. In certain types of turret lathes, the bed is cast integral with the head to give additional rigidity.

V-Lubrication

The carriage is usually held in position on the lathe bed by means of V-shaped projections which travel in corresponding grooves in the bed. V-lubrication is important due to the fact that abnormal wear will contribute to operating difficulties and the possibility of misalignment. For this reason, sliding surface lubrication must be given careful attention. They can be effectively lubricated by felt wipers in the sliding element or on the end of the carriage. These wipers also keep the bed V's clear of dirt.

Other designs provide for automatic flood lubrication. Still others make use of revolving wheels located in the bedplate, which are so installed as to come in contact with the mov-



Courtesy of Pratt & Whitney Division, Niles-Bement-Pond Company

Fig. 3—Top view of the headstock gearing of a Pratt & Whitney Model "C" lathe. A flood of clean, cool, filtered oil continually pours over the gears and bearings, while the lathe is in motion, being circulated from the reservoir below by a suitable pump inside the headstock. Oil level and sight gages complete the system.

ing element as it slides over them. These wheels are usually located in a depression which can be partially filled with oil. As they revolve, they carry a film of oil to the moving slide.

Courtesy of Sundstrand Machine Tool Company

Fig. 4—The Sundstrand automatic stub lathe is provided for automatic pressure lubrication to the close fitting hardened steel ways, and other bearings. Note three views of the sight gages on the circulating system.

Cam Lubrication

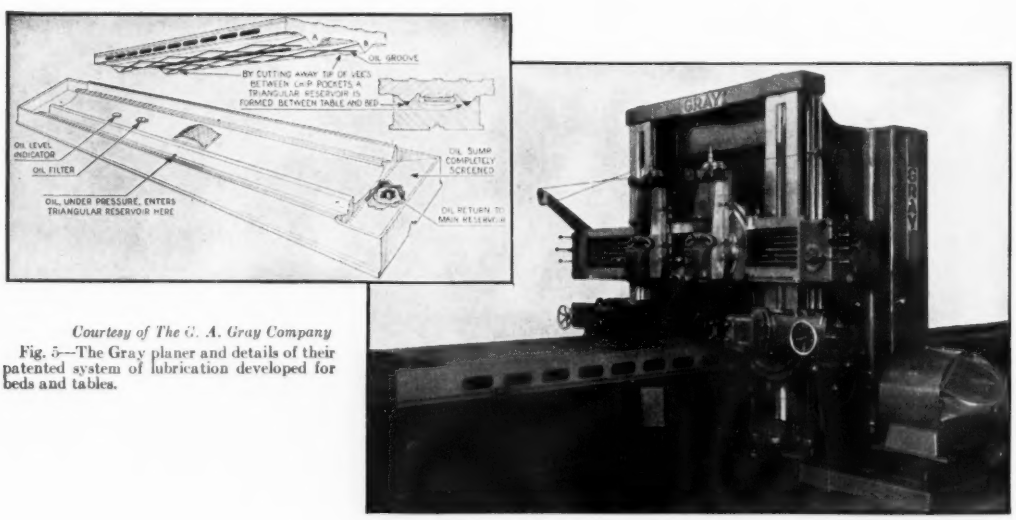
While cams are not extensively installed on most types of lathes, it being found feasible to eliminate them in the design of the moving parts, certain machines will require them for the operation of the reciprocating turret slides, and the work-holding and feeding chucks.

Cams may involve much the same principles as do guides, or they may be based on a combination of rolling and sliding motion. Irrespective of their design, it is absolutely essential to prevent abnormal wear, otherwise lost motion and inequalities of operation will occur to promote imperfections and inaccuracies in cutting. Cam lubrication is, therefore, a matter of moment and quite as important as the lubrication of guides and bearings.

THE PLANER

Spur, helical or worm gears predominate in the table drive on the modern planer. In construction this drive consists of a rack which extends over the length of the entire underside of the table. The "bull" gear or main gear of the driving train meshes with this rack. Intermediate gears are provided to bring about the necessary speed reductions from the driving element. In the worm drive planer a worm takes the place of the "bull" gear; the table rack, however, remains the same.

Quite a difference exists between the cutting and return speeds. As a rule, the latter will be from two to four times the former, depending upon the size of the machine, and extent of cutting which may be necessary.


OIL GROOVE
BY CUTTING AWAY TIP OF VEES BETWEEN LHP POCKETS A TRIANGULAR RESERVOIR IS FORMED BETWEEN TABLE AND BED
OIL LEVEL INDICATOR
OIL FILTER
OIL SUMP COMPLETELY SCREENED
OIL, UNDER PRESSURE, ENTERS TRIANGULAR RESERVOIR HERE
OIL RETURN TO MAIN RESERVOIR
GRAY

Courtesy of The G. A. Gray Company

Fig. 5—The Gray planer and details of their patented system of lubrication developed for beds and tables.

Gear lubrication is regarded by many as the salient factor in efficient planer operation. The occurrence of rolling and sliding friction between the respective teeth as they pass into

and out of mesh is well known. Theoretically, this would take place whether the gears were run dry or not. Actually, however, the continued occurrence of solid friction would tend to supplant rolling friction with sliding friction. Wear would then tend to increase proportionally.

The substitution of fluid friction for solid friction which is brought about by the use of a suitable lubricant which will permit of the formation and maintenance of the proper film over the gear teeth, will enable rolling contact to predominate as originally planned, unless faulty operation occurs, such as the gears working out of alignment.

Wherever gear lubrication must be carried out independently of the V's and bearings in the planer, the type of gears and their mode of operation must be taken into consideration, just as has been explained for the lathe. Therefore, lubricants as specified or used for these latter will be equally satisfactory if applied to the planer gears. The tendency is more and more to enclose all such gearing in an oil-tight housing; not only does this reduce the hazards of operation, but it enables more effective gear lubrication, and oftentimes eliminates the necessity for using the heavier lubricants so essential to exposed gears.

Guides and Bearings

The essential sliding or bearing mechanisms involved in the average planer include the table V's or guiding grooves such as are described for the lathe, which serve to keep the table in proper alignment with respect to the cutting tool; and such other guides as are necessary to hold the various reciprocating parts in position.

V-lubrication is naturally of chief importance, for the accuracy and degree of perfection of the work performed will depend upon the accuracy and extent to which these guides maintain alignment.

Planer V's are subject to considerably higher pressures and more wear than the corresponding parts on a lathe. For this reason, they are generally lubricated by force feed or by means of automatic oil rollers of some form.

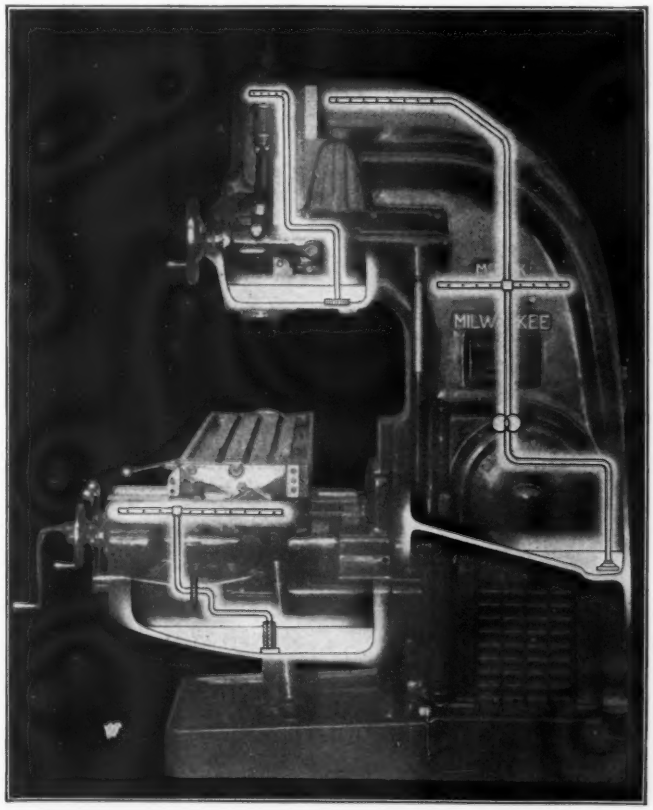
Where force feed lubrication is employed, it is usually customary to have it serve not only the V's, but also the guides, bearings, and gears of the rail and other mechanisms. In such a system either a force feed lubricator or an oiling device, including a suitable independent pump and reservoir, may be used.

MILLING MACHINES

In the development of the modern milling machine, there has also been a decided trend towards automatic lubrication of gears and bearings.

A milling cutter performs its work at a single pass, and removes metal at a relatively rapid rate. Therefore, it is absolutely necessary that the work table, spindle, and all supports and operating mechanisms be so designed and constructed as to involve no tendency for the work to spring away from the cutter, or vice versa, when it is subjected to the stress of cutting.

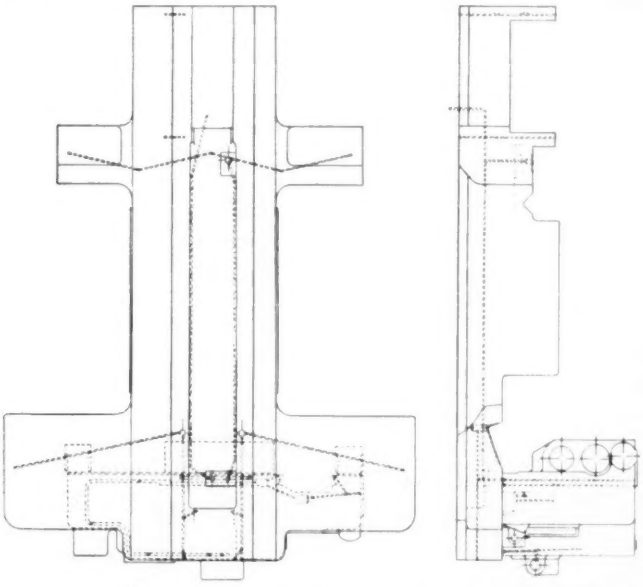
It would not suffice, however, to rely upon rigidity and strength alone to take up these cutting strains. Wear on all frictional ele-



Courtesy of Kearney & Trecker Corporation

Fig. 6—The Kearney & Trecker Milwaukee milling machine, showing details of the automatic force feed oiling system. Pressure pumps are located in the column, knee, and sliding head to furnish full automatic lubrication.

ments would probably only be increased in proportion. Therefore, positive lubrication must be developed. This requires a continuous feed of oil directed to all wearing parts under sufficient pressure to preserve a suitable fluid film between them and prevent metal-to-metal friction.



Courtesy of The R. K. LeBlond Machine Tool Company

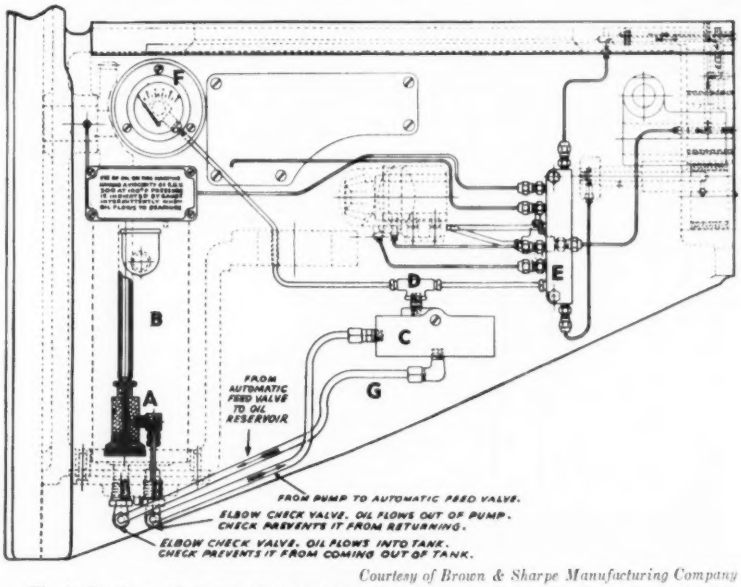
Fig. 7—Oiling diagram showing distributing lines to the apron and carriage on a LeBlond heavy duty lathe.

The extent to which such a lubricating system would have to be planned would, of course, depend to a large degree upon the working pressures which might be developed. To meet such conditions, some milling machine builders have found that the installation of suitable oil reservoirs or independent force feed lubricators not only simplifies their problem, but affords the necessary amount of lubrication, even though the bearings, etc., are not flooded with oil. In contrast there are other builders who regard flood lubrication as so essential that they have designed their machines with absolutely self-contained oiling systems, the lubricant being pumped to the wearing parts by means of a suitable pump adjacent to or located in the oil reservoir itself. Thus, throughout operation, a flood of oil is continually passing over all gears and bearings. In such a system, the one grade of oil, i.e., a medium-bodied straight mineral machine oil of from 300 to 500 seconds Saybolt viscosity (at 100 degrees Fahr.), will usually give satisfactory lubrication of the various moving parts.

Somewhat heavier oils may be required, however, in bath lubricated systems. The latter are particularly adaptable to column mechanisms; here, with the gears of the drive shafts running submerged in oil, a sufficient amount of this latter is splashed to all parts of the column to effectively lubricate the bearings. The lubricant does its work under relatively low pressure, volume being relied upon to maintain the requisite oil films.

SHAPERS AND SLOTTERS

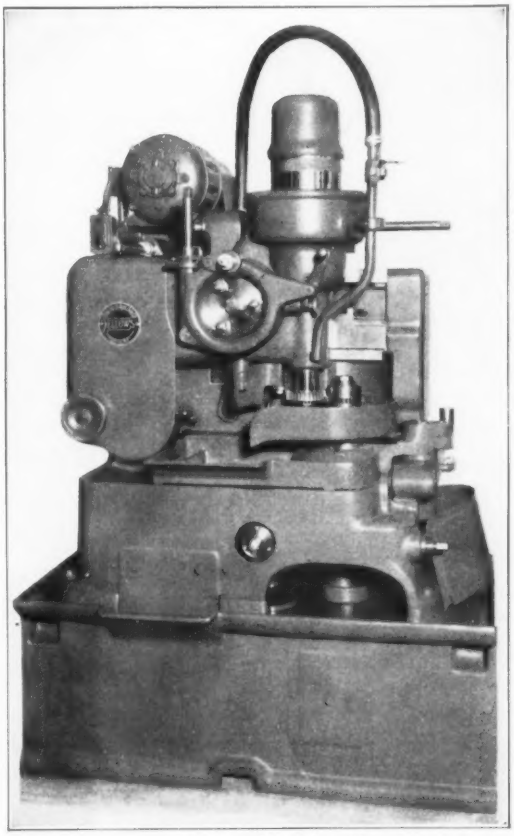
Lubrication of the shaper or slotter differs but little from that of the planer. Essentially the same variety of operating mechanisms are involved, hence the same respective grades of lubricants can be used with equal satisfaction. Automatic lubri-


F
B
A
C
D
E
G
FROM AUTOMATIC FEED VALVE TO OIL RESERVOIR
FROM PUMP TO AUTOMATIC FEED VALVE.
ELBOW CHECK VALVE. OIL FLOWS OUT OF PUMP. CHECK PREVENTS IT FROM RETURNING.
ELBOW CHECK VALVE. OIL FLOWS INTO TANK. CHECK PREVENTS IT FROM COMING OUT OF TANK.

Courtesy of Brown & Sharpe Manufacturing Company

Fig. 8—Details of the automatic lubricating system in the knee of the Brown & Sharpe light type milling machine. Plunger pump "A" delivers oil from reservoir "B" to automatic feed valve "C"; thence through fitting "D" to header "E," from which oil tubes lead to all lubricating points. Gage "F" indicates the pressure. "G" is a return or bypass pipe to the reservoir which functions when the system is filled with oil and pressure builds up.

cation, while, of course, not universal, is nevertheless generally regarded as an advantage by many leading machine builders.



Courtesy of The Fellows Gear Shaper Company

Fig. 9—Front view of the Fellows No. 7-A high speed gear shaper.

In these machines, pressure lubrication by means of oil, involving some form of plunger or geared pump is applicable, just as it is to the planer and certain other types of tools. Pressure lubrication is especially advantageous on machines doing deep cutting of hard steel where the reaction pressures exerted on some of the gears and bearings may be comparatively high.

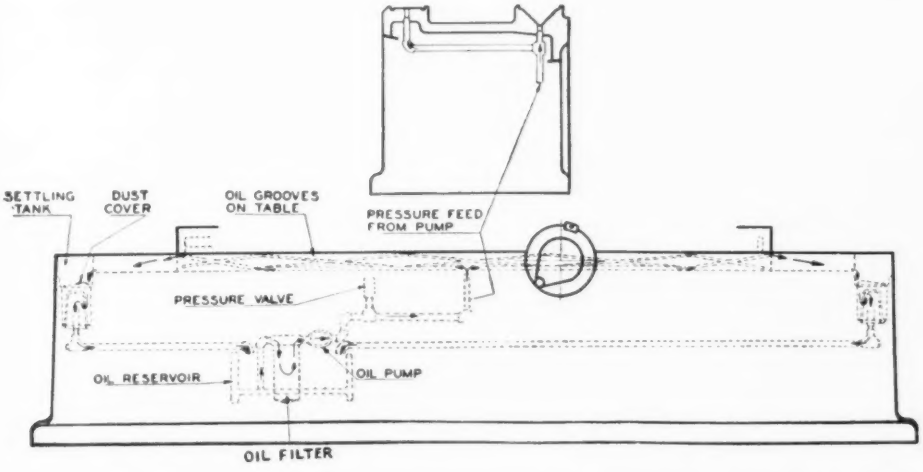
Where clearances are relatively high, wear might not become abnormal for the lubricating film would be thicker. But high clearances are not conducive to accurate cutting; therefore, they should be always kept within the limits of practical operation. This, however, might interfere with the maintenance of a suitable lubricating film, especially where hand oiling is relied upon. So it is in the interests of economy of upkeep and maximum production to resort to automatic lubrication as a general rule.

DRILLS AND BORING MILLS

Drills and boring mills are identified according to size. The former are used for small work. The latter for boring out machine parts, such as car wheels, engine connecting rods, etc., and differential housings or crankcases in the automotive industry. One of the most frequent functions of a boring machine is to prepare the aperture, which is to ultimately house a shaft and its accompanying bearing.

Boring Mill Service

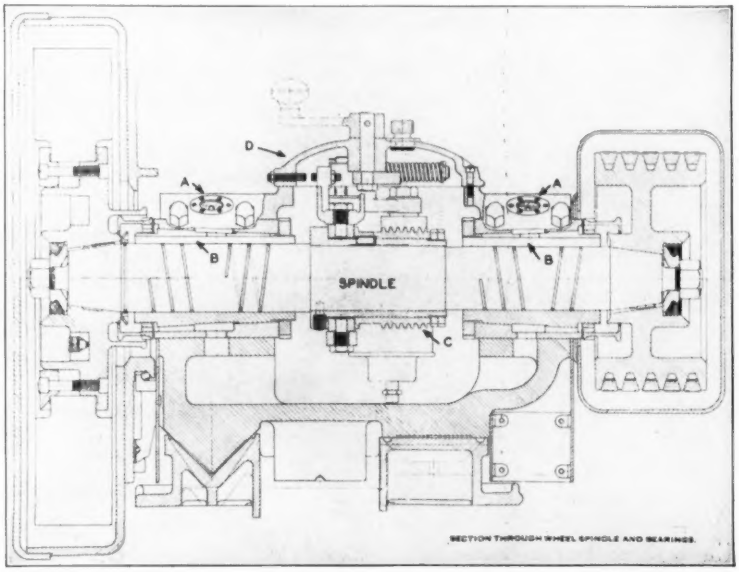
Boring mills are built either horizontally or vertically, according to the work which is to be handled. The horizontal mill is adaptable



Courtesy of Cincinnati Milling Machine and Cincinnati Grinders, Inc.

Fig. 10—The lubricating system on a Cincinnati cylindrical grinder showing how low pressure filtered oil is circulated to the table ways

to work which cannot be readily revolved, the tool, therefore, being the rotating element. This machine is also suited to the boring of long or deep holes and the boring of more than one hole in the same piece, especially where these holes are located in different planes. The horizontal boring mill is also capable of milling and drilling.



Courtesy of Norton Company

Fig. 11—Assembly of the Norton grinder wheel spindle unit. The spindle runs in bronze bearings "B," which are tapered on their outer diameter and drawn into cast iron cases. Lubrication is maintained by a small pump driven by a spiral gear from Worm "C" on the spindle. This pumps spindle lubricant from a reservoir in the wheelslide through an external filter, and thence to each bearing. Flow of lubricant is observed through a sight window "A" above each bearing; it can be regulated by a cock adjacent thereto. The same lubrication system serves the end thrust, the worm drive, and reciprocating parts by direct application through flexible tubing (to the end thrust parts), or by spray deflected from the housing cover "D".

Kerosine is successfully used for lubricating this entire mechanism. Important factors in the maintenance of low viscosity lubrication are well flushed bearing surfaces, proper bearing adjustment, and provision for taking complete advantage of the cooling ability of the lubricant. In the Norton assembly, all parts are fully protected by lubrication at temperatures which rarely exceed 120 degrees Fahr.

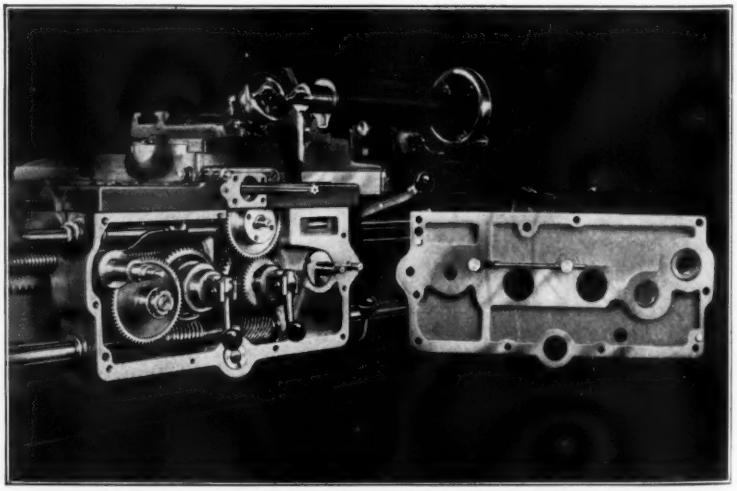
The vertical boring mill, in turn, is adapted to work which can be revolved, and where balance is a factor to reduce the effects of centrifugal force. In other words, it is used for work which can be fastened to the table and rotated thereon. As a rule, therefore, machine parts of relatively smaller caliber, such as pulleys, gears, piston heads, machine discs, and casings, etc., are finished on vertical boring mills.

Essentials of Lubrication

Boring mills involve much the same type of moving parts as the lathe, or planer, etc. In other words, there are the driving gears, the feed and traverse gears, the screw by which the table and saddle are adjusted, the V-tracks on which the saddle rests, and the miscellaneous bearings and guides involved in connection with the above.

In certain types of boring mills, considerable thrust will be exerted upon the spindle or boring bar. This is especially prevalent on the horizontal machine; for this reason, many such mills are built with V-tracks on either side of the spindle. These V's take up the thrusts of operation effectively, provided they are properly lubricated.

Pressure lubrication is widely used on the boring mill. Builders have realized the enormous pressures which must sometimes be carried by certain of the wearing parts of their machines. They have furthermore realized that where equipment of the size and complexity of the boring mill is involved, the most dependable results are attained if the operator is not expected to combine the duties of an oiler with his more specific duties of producing



Courtesy of Pratt & Whitney, Division Niles-Bement-Pond Company

Fig. 12—Positive oiling on the P. & W. Model "C" lathe is provided for the carriage ways and bearings within the apron.

the maximum of correctly machined products.

For the general lubrication of boring mills, a medium bodied straight mineral oil has been found to be most satisfactory. Essentially it must be of the same characteristics as the oil used elsewhere in the shop. For all-round lubrication, a viscosity of from 300 to 500 seconds Saybolt at 100 degrees Fahr., will be suitable. Such an oil will have sufficient body to not only serve the bearings, but also the slides and enclosed gears, where it is delivered under sufficient pressure.

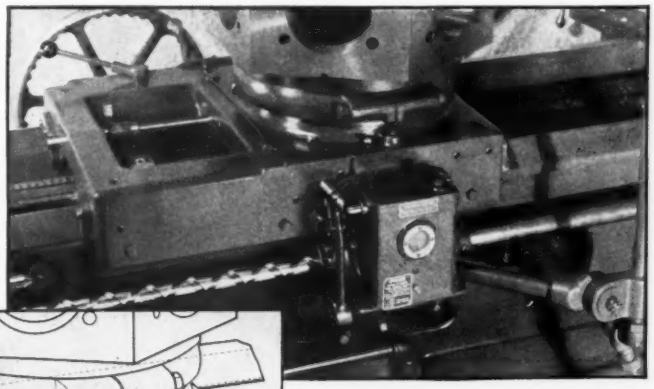
Where gears are not enclosed in oil tight casings or on rack, worm, or screw mechanisms, a somewhat heavier product may be advisable. Usually a viscosity of approximately 1000 seconds Saybolt at 210 degrees Fahr., will suffice for such service. For other gearing which operates enclosed and designed for splash lubrication, a straight mineral oil similar to an automotive gear lubricant will be applicable, i.e., within the S.A.E. 90 to 140 range.

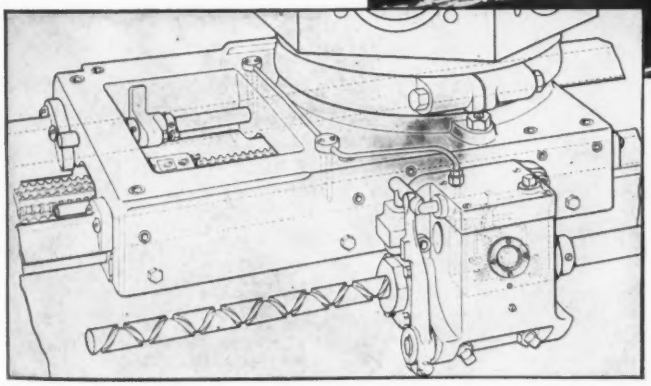
Courtesy of The Monarch Machine Tool Company

Fig. 13—The Monarch lathe with details of the automatic force feed lubricating system by which oil is delivered in metered quantities to all moving parts. Only fourteen points require oiling by this system.

Drilling Machines

The tapping and drilling of relatively small holes, along with reaming or counterboring, either singly or in multiple, is done by drills of vertical, radial, horizontal, or multiple-spindle type. High speeds are advantageous in such work.



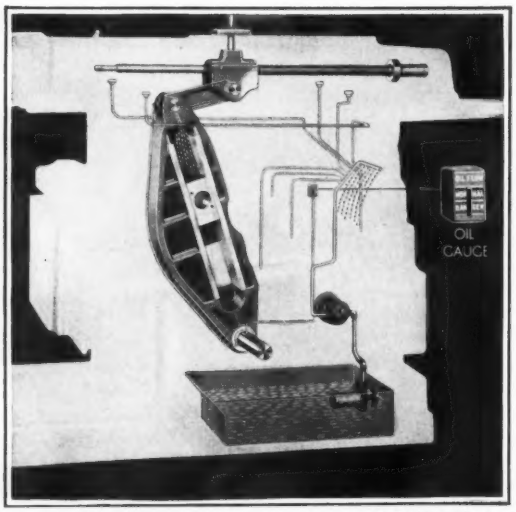


Courtesy of The Warner & Swasey Company

Fig. 14—Lathe turret lubrication is developed by Warner & Swasey by pressure pump circulation of oil. A built-in oil reservoir with suitable oil leads therefrom furnishes lubrication for the ways.

Lubrication Details

High speeds and maximum production, however, are only possible provided the working parts of the drill function absolutely in unison with respect to one another.



Courtesy of Gould & Eberhardt

Fig. 15—Oiling diagram of a G. & E. shaper, showing relative location of the oil reservoir, pump, and accessory piping, with oil flow indicated.

Centralized automatic lubrication has been developed to assist in attaining this objective. The essential purpose, of course, is to insure a sufficient supply of lubricant to all wearing parts of the drill. This should be borne in mind, irrespective of the design of the equipment or the means provided for rendering it automatic. The system, however, should never be so complicated as to involve difficulty in repair, or abnormal possibility of breakdown. Centralized automatic lubrication also enables the use of one grade of oil, thereby eliminating storage problems and the possibility of difficulty due to application of the wrong product at any time.

In connection with gearing, however, as with boring mills and other machine tools, there are, of course, some cases where these mechanisms will be designed for individual or separate lubrication. Naturally, bath or splash oiling is preferable, and, in such instances, the same products heretofore specified under boring mills would be suitable.

Exposed gearing or other toothed mechanisms running perhaps in non-oil tight casings, on the other hand, will require a heavier product which will maintain an effective lubricating film on the teeth, notwithstanding any action of centrifugal force which may be prevalent.

OTHER TYPES OF MACHINE TOOLS

There are, of course, a number of other types of machine tools used for more specific service. We have in mind the grinder, screw machine and thread cutter, the hobbing machine, and chucking machine, etc. While to an extent more limited in application than the more massive tools already discussed, they cannot justly be classified as auxiliaries, even though they may amount to this in many shops. Their functions are distinctive, and quite as important in finishing certain types of work as their heavier-duty counterparts.

The principles of operation will be much the same, i.e., the working of the material into suitable shape and design for subsequent use as tools or machine parts. This is brought about by cutting, as in the gear-hobber, or by grinding, as in the grinder. In consequence, such equipment will function by virtue of suitably arranged gearing, bearings for the rotating members, and guides or slides for such parts as may be reciprocating in their motion. The grinding machine is a distinct adjunct to lubrication, for today the perfection of bearing surfaces is being given most careful attention. So carefully are grinder spindles and bearings prepared, that they themselves are being satisfactorily lubricated by very low viscosity lubricants such as kerosine.

Lubrication Procedure

Elsewhere lubrication will, therefore, differ but little from that already discussed. While the use of independent oil and grease cups will often be the most economical and satisfactory equipment, automatic or flood lubrication is also provided for by certain builders. It all depends on the design, the speed at which the machine is to operate, and the bearing or frictional pressures which may be involved.

In consequence, the same varieties of lubricants as recommended elsewhere in this article will, in general, be applicable to similar wearing parts on these machines. For example, in splash or force feed lubricating systems, a 300 to 500 viscosity machine oil should be used. For grease lubricating systems, a grade of grease should be used which, under the operating temperatures involved, will function with minimum leakage. It should also resist chemical breakdown and oil separation.

METHODS OF LUBRICATION

Broadly speaking, bearing lubrication in machine tools is a matter of oil or grease lubrication. These two classifications can be further subdivided, according to the method employed for handling the lubricants. Oil, for example, is applied by continuous circulation under pressure, or in measured quantities by the mechanical force feed oiler, or a centralized pressure system. Grease, in turn, by pressure gun, grease cup, or a centralized pressure device.

The Mechanical Force Feed Lubricator

This mechanism is the simplest of the measured oiling devices. It can be readily driven by the machinery which it serves; it can be made to function only when the latter is in operation, and then only at a proportional speed. In other words, the higher the speed of operation, the more oil will be delivered. The pumping capacity and rate of oil flow is, therefore, variable. As a result, such a lubricator will automatically start or stop with the machine to which it is attached.

Mechanical lubricators have been very successfully applied to a wide variety of machine tools where it is practicable to drive the lubricator by direct connection from some external moving part. This can be brought about by a link mechanism, an eccentric located on some rotating element, through belt connection from the machine itself, or by the use of an electric motor and speed reduction mechanism.

The use of a mechanical force feed lubricator for certain types of large machines may be limited, however, in that the capacity is oftentimes comparatively small in contrast with a flood circulating system, hence requiring more frequent filling. On the other hand, this will depend upon the extent of operation, the number of oil feeds, and the rate of delivery. This latter must be worked out in actual practice, according to the requirements of the bearings and the viscosity of the oil being used.

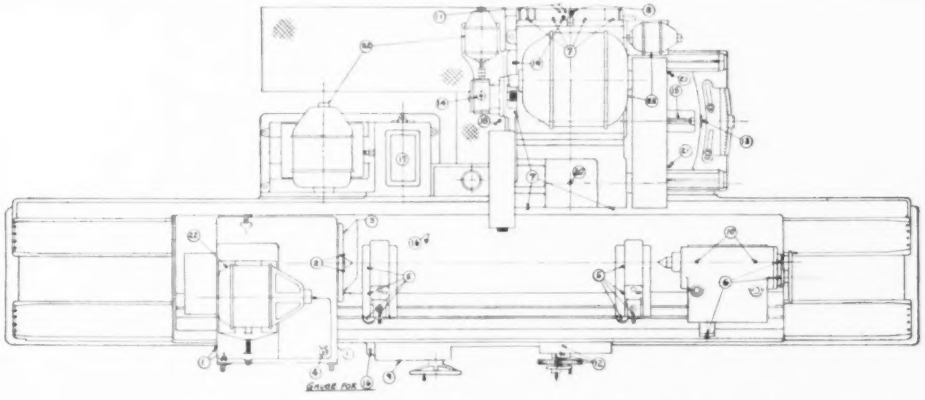
Effect of Operating Pressures

In the selection of virtually any means of pressure lubrication, it is important to have at least an approximate idea as to the operating pressures which will prevail at the various bearings. This is especially true in the case of mechanical force feed oilers. Where circulating flood lubrication is involved, volume in company with the pump pressure can be depended upon to maintain the necessary lubricating film between the wearing elements. With the mechanical force feed oiler, on the other hand, pressure alone is involved. The volume is limited; pump pressure should, therefore, not vary to any wide degree, nor should the lubricator be allowed to run dry; otherwise, lubrication would cease in a comparatively short time.

Centralized Pressure Lubrication

Another interesting phase in connection with pressure lubrication has been the development of a means of centralized lubrication which functions by virtue of a central control, all wearing parts so served being flushed and supplied automatically with oil from a central reservoir. By locating this latter adjacent to the machine to be lubricated within ready reach of the operator, and equipping it with a suitable plunger which operates the pump, lubrication of all parts connected thereto becomes but a matter of operating the discharge mechanism. Common practice on new designs is to build the lubricating unit right into the machine. This method of lubrication is well adapted to lathe aprons and milling machine saddles. In such a system the amount of lubricant fed is restricted to as nearly as possible the theoretical lubricating requirements of the respective bearings.

Since certain bearings will vary from others in regard to their oil requirements, it is necessary to provide for some arrangement of regulation or control of flow. So the oil is measured by drops. This is accomplished either by proper individual construction of the drip plugs, which, on such equipment, are also known as control outlets; by use of a control device located at the base of the pump, or by



Courtesy of Farrel-Birmingham Company, Inc.

Fig. 16—Lubrication diagram for a Farrel-Birmingham work moving roll grinder. Points 1 to 9 inclusive are pressure grease fittings; 10 to 13 inclusive are Bowen oilers; the other points provide for grease or oil application, according to chart instructions.

the installation of suitable adjusting manifolds at salient points in the system.

Properly installed, such systems are claimed to be relatively fool-proof, exceedingly simple to operate, and an insurance that clean oil will be delivered to the respective bearings. All parts, however, must be durable and capable of withstanding jars, shocks, and temperature fluctuations.

To insure that clean oil is used, suitable filtering media, such as a felt pad or screen, are employed which will normally effectively remove any foreign matter that may have entered the oil in the course of storage or handling prior to usage.

Pulsating Control

By use of the principles of pulsation and a suitable pressure control valve to regulate the oil flow, the necessity for manual operation can be done away with. The lubricator itself is driven by belt or gear connection from any rotating part of the machine to be served. This is a benefit where an extensive number of bearings are to be served, for the entirely automatic feature eliminates the possible factor of human error; the only alteration required occurs when the oil reservoir is to be filled or any individual feeder adjusted.

In such a system, the oil is fed only during a pulsation or high pressure period in the cycle of pump operation, control being maintained by a suitable plate valve arrangement. An added feature is the practicability of flushing the entire system under the prevailing pressure at the high pressure period by pressing down a suitable flushing button which is a part of the pump unit.

Continuous Lubrication

Continuous or flood lubrication involves a directly opposite theory to intermittent or measured lubrication, inasmuch as the bearings, etc., are literally flooded with an excess of oil. Here the oil acts not only as a lubricant, but also as a cooling medium to carry off any frictional heat that may be developed.

Flood lubrication also keeps the bearing surfaces free from dust, dirt, and metallic particles to reduce the tendency toward abnormal wear or scoring of the shaft or bearing. In certain installations, the oil from a continuous oiling system can be drained to some central point of collection from which it may be removed when desired, and filtered or centrifuged in order to effect purification.

Continuous oiling may be broadly grouped into two classifications, i.e.:

1. Splash lubrication
2. Force feed lubrication

Splash Systems

Splash lubrication in machine tool service is developed by gearing. It is adaptable where the crankcase or oil sump is completely enclosed and the entire system is oil tight. In general, splash systems have some provision installed for picking up the oil from the base of the machine and transmitting or throwing it to the points to be lubricated.

In equipment lubricated by splash systems, a quick water and sediment separation is imperative. The viscosity of the oil in a splash system should, therefore, be as low as is consistent with requirements in order to insure rapid precipitation.

Few lubricants receive any harder service than those involved in systems of this type, since they are used over and over again, frequently without purifying or external cooling. As a result, the capacity of the reservoir should be sufficient to allow the oil a certain period of rest.

Pressure Circulating Systems

In a pressure circulating system, the oil is forced into the bearings at pressures ranging normally from 5 to 15 pounds per square inch. This may be obtained either by making use of the action of gravity or employing oil pumps, along with a simplified system of oil piping.

Where gravity is involved, suitable storage tanks are located at a sufficient elevation above the bearings to produce a head corresponding to the required pressure.

In oil pump installations, the oil is passed in a continuous cycle through the bearings, and then filtered and cooled, etc.

Lubricants used in such a system have their requirements controlled to a large extent by operating and constructional conditions. When the system includes ample purifying and circulating capacities, the oil will be subject to comparatively light duty, inasmuch as bearings are continually washed out, and there is opportunity for dirt and water to precipitate. Also, as there is an adequate and continuous flow of lubricant, it will be generally unnecessary in such a case to select an oil capable of standing extreme temperatures or pressures. It is only necessary that the oil shall resist emulsification and be free from corrosive acids. Emulsification would clog the system, while acids would cause deterioration of the piping, filters, settling tanks, bearings, etc.

Ring and chain oilers are used to a certain extent in production service, and involve flood lubrication within the ability of the rings or chains to transmit the oil to the bearing. The same conditions hold for lubricants for this type of service, as have been mentioned under splash lubrication.

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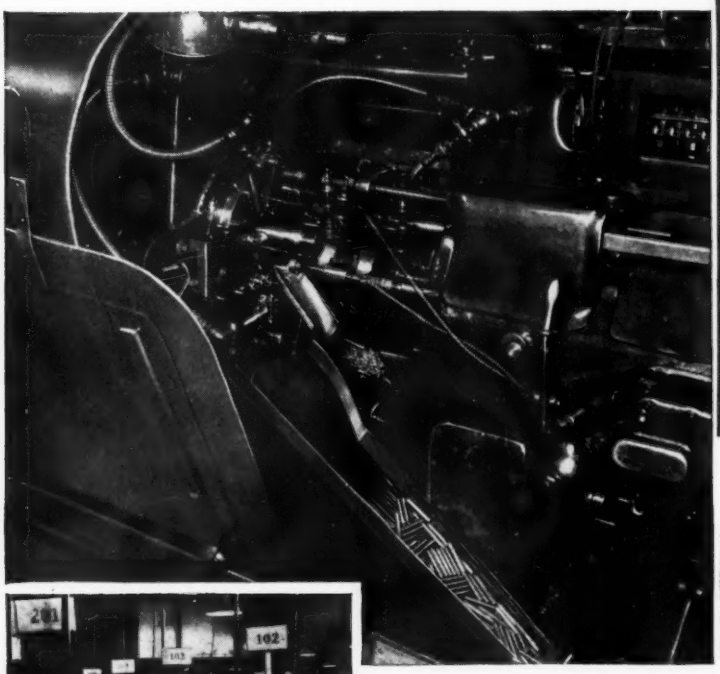
TEXACO

In the Lubrication of Machine Tools

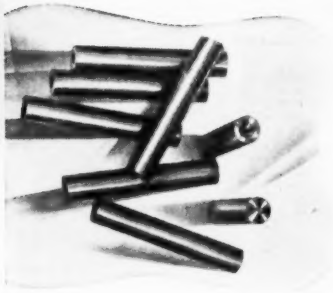
TYPE OF TOOL	METHOD OF LUBRICATION	TEXACO RECOMMENDATION
LATHES, PLANERS, SHAPERS, SLOTTERS, MILLING MACHINES, DRILLS AND BORING MILLS, ETC.	**GENERAL MACHINE LUBRICATION**	
	Pressure Lubrication Systems	TEXACO Regal Oils or TEXACO Nabob or Aleph Oil
	Splash Lubricated—Gears and Bearings	TEXACO Regal Oils or TEXACO Aleph Oil or Altair Oil
	Bath Lubricated—Gears and Bearings (According to size and severity of service)	TEXACO Aleph Oil or Altair Oil TEXACO Thubans TEXACO Pinnacle Cylinder Oil
	Individual Oilers—Bearings and Slides	TEXACO Aleph Oil, Altair Oil, or Aries Oil
	Grease Lubrication—Bearings and Slides	TEXACO Cup Greases
	For High Speed Bearings with Low Clearances	TEXACO Regal Oil A or B, or TEXACO Libra Oil or Nabob Oil
	BALL AND ROLLER BEARING LUBRICATION	
	Where housings are oil-tight	TEXACO Spica Oil, TEXACO Capella Oil, or TEXACO Cetus Oil
	Where Grease Lubrication is necessary	TEXACO Starfak Greases or TEXACO Marfaks
	SPECIAL CONDITIONS	
	Exposed Gearing, or where housings are not oil-tight.	TEXACO Thubans, TEXACO Crater, or TEXACO Marfak No. 1

NOTE: Wherever a general machine lubricating oil is to be used as a cutting tool lubricant and coolant, it may be advisable to use a product of somewhat lower viscosity than any of the above. In such cases, a TEXACO Engineer should be consulted.

MAGNET CORES drilled, tapped, cut off



600 PIECES AN HOUR



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